

A NEW HISTOLOGICAL REGION IN *HYDRA*
OLIGACTIS PALLAS.

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Three anatomical regions are to be recognized in *Hydra*: (1) the oral end bearing tentacles, peristome and mouth; (2) the middle region; and (3) the basal region. In this oral region Kepner and Hopkins ('24) described, in detail, the peristomal endodermal glands that lie about the mouth. They also demonstrated the presence of sphincters at the bases of the tentacles. These sphincters operate against pressure from the enteron towards the tentacles but not in the reverse direction. The histology of the middle region has recently been intensively studied by Hadzi ('09). In this region he finds three types of cells presented by the endoderm: (1) epitheliomuscular cells, that are capable of ingesting small food-particles; (2) gland-cells, which lay down enzymes upon larger masses of food within the enteron; (3) (3) sensory cells. Hadzi, in this respect followed closely Schneider ('90), ('02) who had seen that each of these types of cells bore one or two flagella. Burch ('28) has carried this one step further in demonstrating that the flagella of the three types of endodermal cells arise from blepharoplasts. Not sufficient attention has been given, as yet, to the peculiar cells that lie laterally disposed in the basal region of *Hydra*. These cells are highly vacuolated and larger in calibre than are the endodermal cells of the middle region. In addition to these features, the endoderm of this region is peculiar because of the absence of gland cells. It is not yet clear to us that these cells bear flagella.

The lateral ectoderm of the basal region of hydra does not differ from that of the middle region. The ectoderm of the basal disc, however, has long been known to be peculiar. Korotneff ('80) wrote "Die Epithel-Muskelzellen des Fusses unterschieden sich von den ubrigen Ectodermzellen. Sie besitzen eine cylindrische Form, enthalten eine stark lichtbrechende Fibrille und zeigen in ihrem oberen Drittel eine gleichfalls stark lichtbrechende mucose Ausscheidung, durch welche die Anheftung des Thieres an fremde

Körper bedingt wird" (s. 165). We have not gotten beyond this early interpretation of the histology of the ectoderm of the basal disc.

With reference to the endoderm of this basal disc, however, we have something to add.

It had been noticed in this laboratory for sometime that hydras are sometimes found at low levels in aquaria with small gas-bubbles attached to the basal discs. Mr. George Dare made a careful series of observations upon isolated specimens and found that this gas was developed at the basal disc of hydra independent of the presence of bacteria or other organisms and of temperature changes. We then undertook the histological study of gas-elaborating specimens. We were able to make longitudinal sections that involved the complete or unbroken wall of the gas-bubble. This was done by gently transferring a hydra, that had a small bubble at its end in a drop of water to a slide. The slide was then placed upon a pinch of salt, that lay upon a block of ice, in such manner that the drop containing the hydra lay immediately over the salt. This resulted in rapid lowering of the temperature of the hydra. When ice crystals began to form about the margin of the water in which the hydra lay, it was flooded with Bouin's fluid. Thus the specimen was fixed and sectioned. The sections show the wall of the gas-bubble to be fixed to the marginal cells of the basal disc (Fig. 1, *g*), and the general or central cells to be in contact with the lumen of the gas-bubble, there being neither secretion material, bacteria, nor other substance lying over their free ends (Fig. 1, *h*). It was thus seen that the wall of the gas-bubble is composed of the mucus-like secretion of the basal disc. The basal ectoderm is, therefore, concerned with the elaboration of both the mucus-like material with which the hydra fixes itself to some submerged surface, and with the elaboration of a gas.

Our chief point of interest, however, lies not in the ectoderm of the basal disc but in the endoderm; for here we find a feature that has not been described. The endodermal cells of the basal region are larger than those of the middle and oral region, and bear great vacuoles. They do not ingest food particles (Fig 1, *e*). In this respect they again differ from the middle and oral regions' endodermal cells. Until recently these cells were supposed to overlie the basal disc's ectoderm. Indeed Curtis and Guthrie ('27) have

illustrated these peculiar cells as lining the fundus of the enteron. In our gas-secreting specimens we find that the fundus of the enteron is lined with endodermal cells that bear numerous food-vacuoles. They are tall, columnar cells having myonemes in their bases. They resemble the epitheliomuscular cells of the middle region of the body. We have not been able to isolate them for maceration methods and cannot, therefore, say that they bear flagella. But they so closely resemble the epitheliomuscular cells of the middle region that our inference is that they do bear flagella. The presence of these cells, therefore, in the fundus of the enteron gives us an epithelial region that is like that of the oral and middle regions of the body except that there are no gland-cells in this basal endoderm.

The new histological region that we have thus discovered lies in the wall of the basal disc. The ectoderm of this region we have found to conform to the descriptions of earlier investigations; but the endoderm is peculiar in that it is an epithelial disc composed of columnar epitheliomuscular cells, that contain food-vacuoles, and which presents no gland-cells.

The presence of this endodermal disc, that is active in food-appropriation, is of interest when we keep in mind the dual function of the basal disc. The elaboration of gas takes place relatively rapidly. The rapid elaboration of gas would, therefore, involve rapid metabolism. The basal disc, then, is a region of relatively high metabolism. The presence of this food-getting endoderm in this region falls in line with the observation of Tannreuther ('09) when he says that "Those endodermal cells of the region of growth, 'the formation of buds and sexual organs', are the most active in ingesting partly digested food from the enteron and preparing it for diffusion into the ectodermal cells" (p. 211).

The basal disc has, therefore, a peculiar endoderm correlated with the dual function of mucus- and gas-elaboration.

The elaboration of gas is done in order that the specimen may be lifted in the water. The gas is discharged into the sac of mucus until the bubble formed lifts the animal to the surface of the water. As the polyp rises it has its basal end directed up and oral end pending. When the bubble encounters the surface film of water, its wall ruptures and forms a somewhat circular disc of mucus,

that is closely applied to the surface film of the water to form a raft by which the polyp hangs (Fig. 2, *g*). Wave-action will destroy this raft and then the specimen will sink. Or the hydra may abstrict itself from the raft of mucus and sink.

SUMMARY.

We have observed that the basal disc's ectoderm in hydra not only secretes adhesive material, with which the polyp fixes itself to some submerged surface, but that it also under certain conditions elaborates a gas. This gas is caught within the mucus-like secretion of the basal disc and retained therein. The bubble, thus retained, increases in size until the hydra is lifted to the surface by it. At the surface of the water the retaining vesicle of mucus breaks and spreads as a circular raft from which the hydra hangs beneath the water's surface.

The ectoderm of the basal disc is thus seen to have a double function. Associated with this region of the ectoderm of hydra there has been found a peculiar region of endoderm. The endoderm of this region is characterized by its component cells having the appearance of the epithelio-muscular cells of the oral two thirds of the body as over against the highly vacuolated epitheliomuscular cells of the aboral third of the body.

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EXPLANATION OF PLATE.

FIG. 1. Longitudinal, axial section of hydra. *a*, peristomal gland-cells of endoderm; *b*, gland-cell of middle region's endoderm; *c*, epitheliomuscular cell of endoderm, bearing two flagella and two food-vacuoles; *d*, epitheliomuscular cell of endoderm ingesting a food particle; *e*, epitheliomuscular cells of lateral endoderm of basal region; *f*, endoderm of basal disc; *g*, mucus-wall of the gas bubble; *h*, basal disc's ectoderm that is exposed to lumen of gas bubble; *i*, ovary; *k*, testes.

FIG. 2. Basal disc of polyp at surface film of water. *s*, surface film of water; *g'g'*, circular raft formed by ruptured wall of gas bubble now applied to surface-film of water; *h'*, ectoderm of basal disc that is now in contact with air.